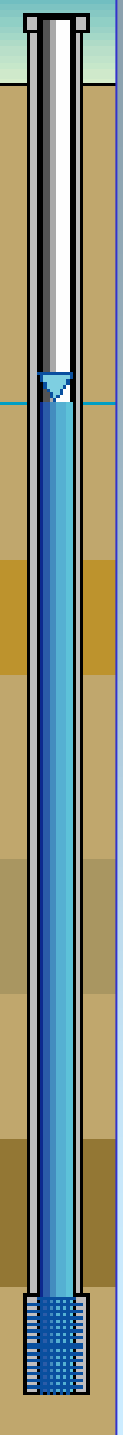


Emerging Tools for Fuel Oxygenate Characterization and Remediation

Eric Nichols, LFR Inc.

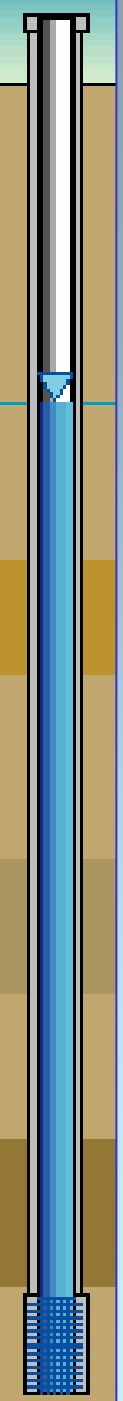
EPA Region 3 and States

LUST Technical Conference

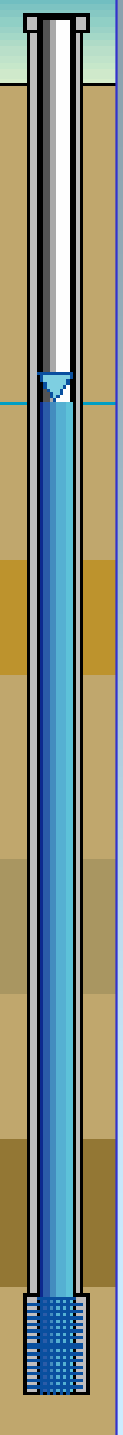
Roanoke, VA
3 – 5 April 2006

LFR

Presentation Overview



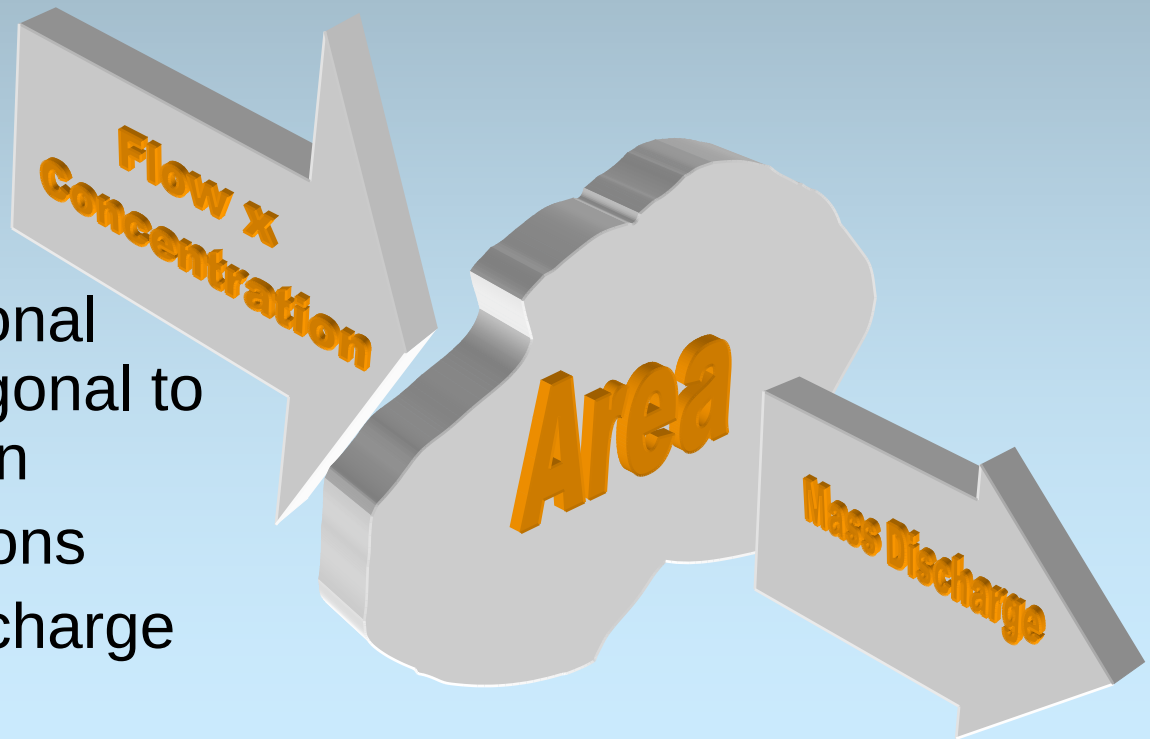
- Tools for Dissolved Mass Flux
- New MTBE/TBA Remediation Guidance Documents

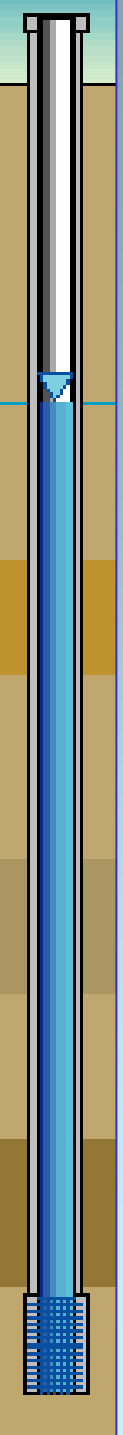


Tools for Dissolved Mass Flux

Mass Flux or Mass Discharge

- Total mass of dissolved-phase constituent migrating through the subsurface over time
  - Cross-sectional plane orthogonal to flow direction
  - Concentrations
  - Specific discharge





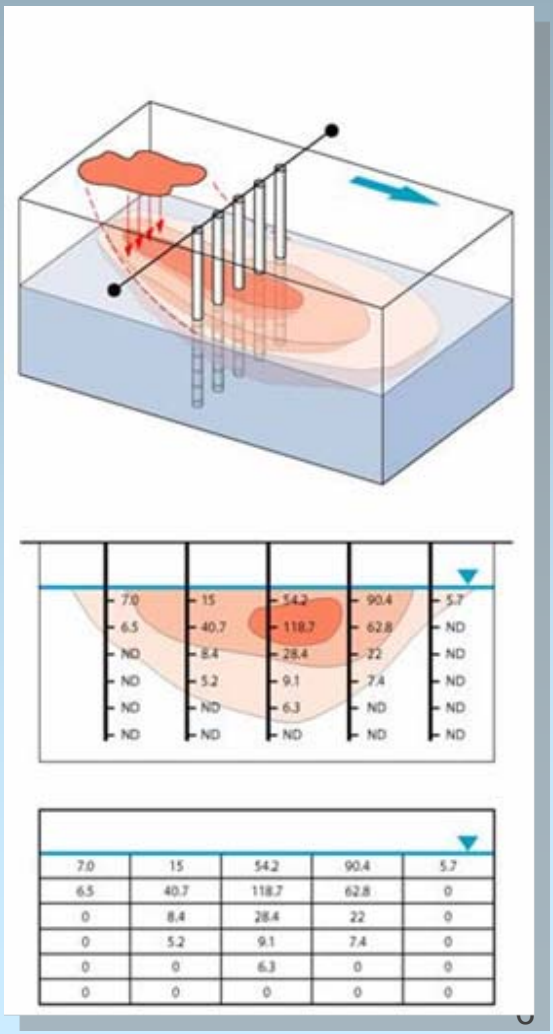
Mass Flux Estimates

- Mass flux estimates can be used to evaluate:
  - Potential water quality impacts on downgradient water supply wells
  - Natural attenuation of contaminant mass with distance downgradient of source
  - Relative benefits of various remedial actions based on anticipated reductions in mass flux from source to receptor

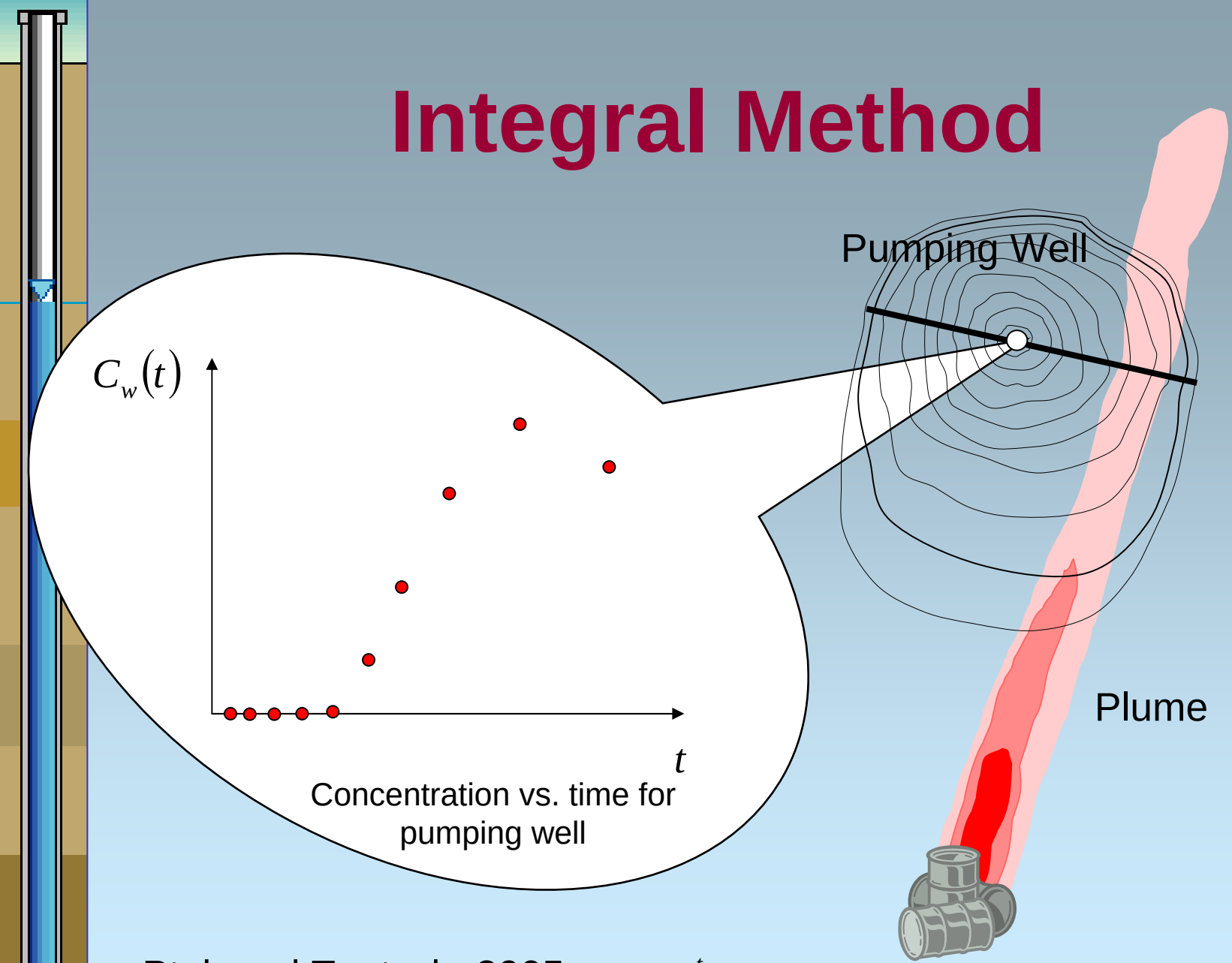
Transect Method

$$M_f = \sum_{i=1}^{i=n} C_i * A_i * q_i$$

- 2D or 3D Network
- Discretize Subareas $i \ldots n$
- Concentrations, hydraulic conductivity
- Sum the subarea fluxes for total mass discharge



Integral Method



Ptak and Teutsch, 2005

$$Q\int_0^t C_w(\tau)\,d\tau = \int_{V_I(t)} C_0(x,y,z)\,n_e(x,y,z)\,dV$$

Supply Well Impacts

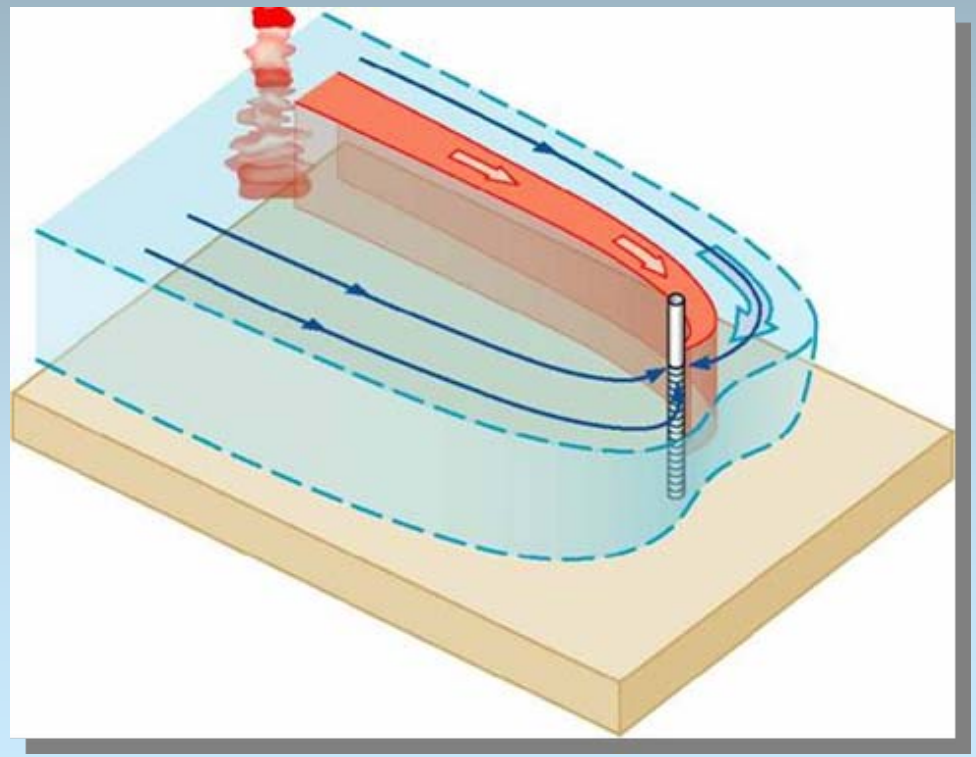
Supply Well Capture of a Plume:

$C_{sw} = M_f / Q_{sw}$

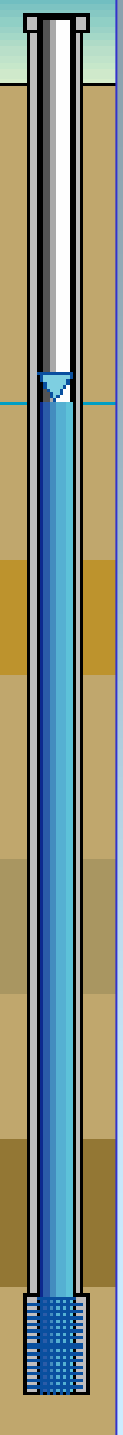
- estimate concentrations in a hypothetical supply well

$M_f = C_{sw} * Q_{sw}$

- calculate mass discharge targets protective of water quality criteria



Einarson and Mackay, 2001

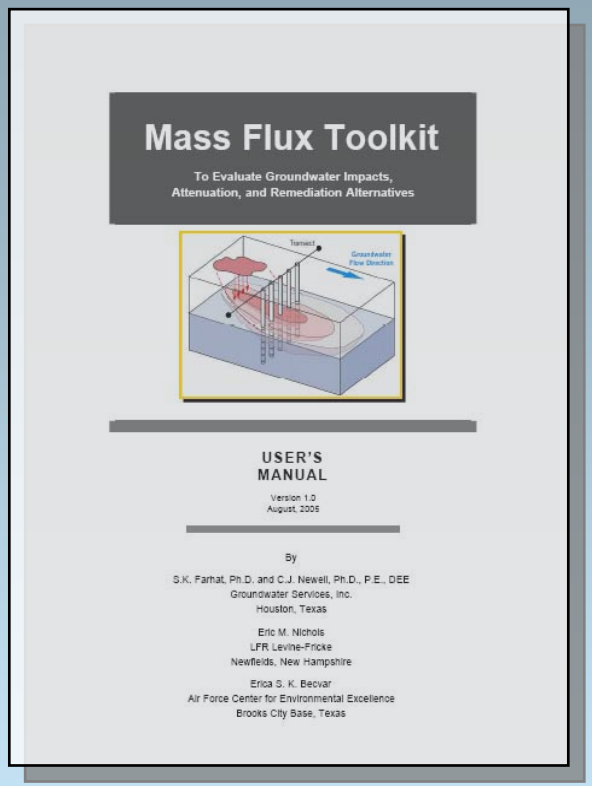


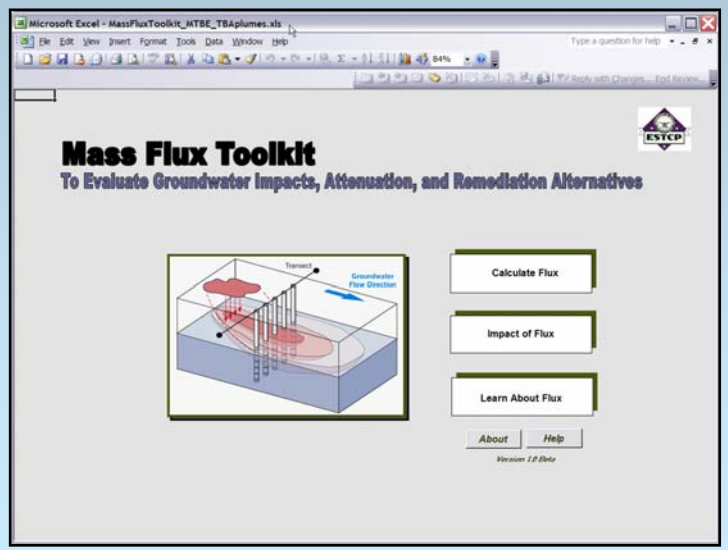
Oxygenates and Mass Flux

- Ether oxygenates and TBA may attenuate more slowly than other fuel constituents
- Plumes may be longer and have increased potential to impact water supply wells
- Therefore, methods that consider mass flux are particularly relevant to ether oxygenates and TBA

Mass Flux ToolKit

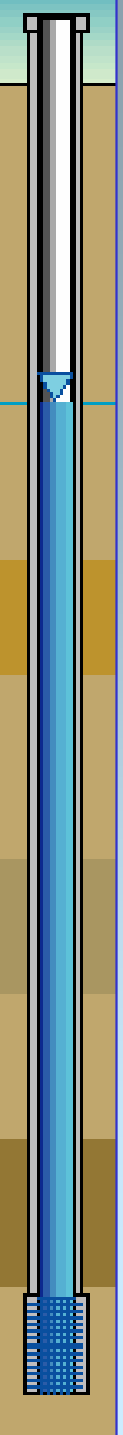
Provides tools to calculate mass flux of contaminants in groundwater





Free software application in Microsoft Excel

Developed for the Environmental Security Technology Certification Program by Groundwater Services, Inc., Houston, Texas with assistance from LFR.



New MTBE/TBA Remediation Guidance Documents

Remediation Guidance from the Interstate Technology and Regulatory Council

- Published in 2005: *Overview of Groundwater Remediation Technologies for MTBE and TBA*
- Release expected in mid-2006: *Overview of Source Zone Remediation Technologies for MTBE and TBA*

http://www.itrcweb.org

Interstate Technology and Regulatory Council

- State-led national coalition of personnel from environmental regulatory agencies
  - 40 states
  - DOD, DOE, EPA
  - Tribes
  - Public and industry stakeholders
- Devoted to reducing barriers to, and speeding interstate deployment of, better, more cost-effective, innovative environmental techniques

ITRC produces guidance documents and provides training

ITRC – Shaping the Future of Regulatory Acceptance

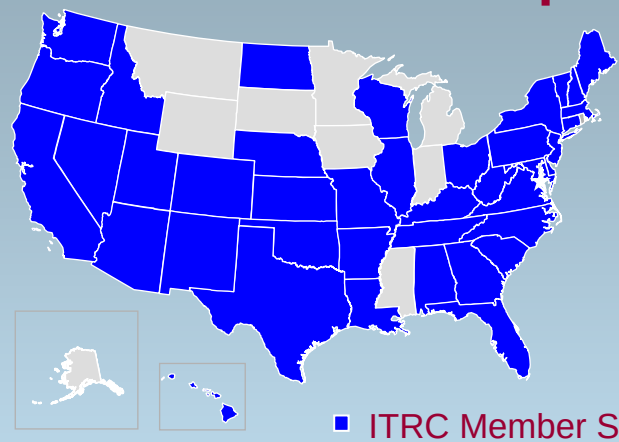
ITRC Internet and Other Training Courses

- MTBE and Other Fuel Oxygenates
- Natural Attenuation
- EISB (Enhanced In Situ Bioremediation)
- Permeable Reactive Barriers (basic and advanced)
- Diffusion Samplers
- Phytotechnologies
- ISCO (In Situ Chemical Oxidation)
- Constructed Treatment Wetlands
- Small Arms Firing Range Characterization and Remediation
- Systematic Approach to In Situ Bioremediation

www.itrcweb.org

ITRC Membership

States



ITRC Member State

Federal Partners

DOE DOD EPA

Sponsors

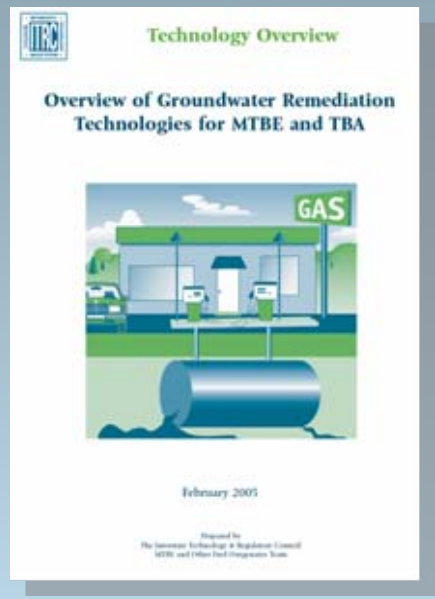
ECOS WGA SSEB

Industry, Academia, Consultants, Citizen Stakeholders

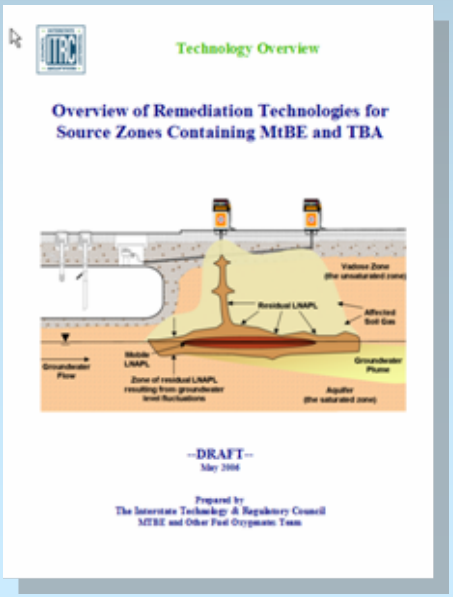
ITRC MTBE and Other Fuel Oxygenates Technical Team

- Current Activities:
  - Finalizing technical overview document "Overview of Source Zone Remediation Technologies for MTBE and TBA"
  - Providing training course "MTBE & TBA: Comprehensive Site Assessment and Successful Groundwater Remediation"

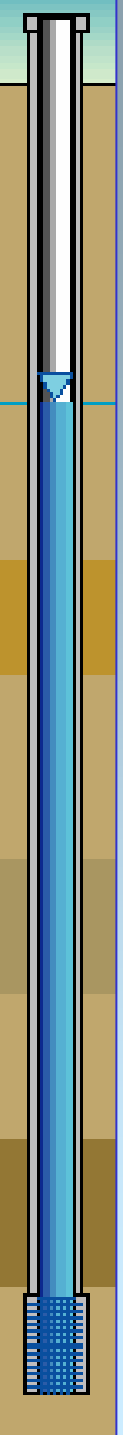
Technical Overview Documents



- 2005 document focuses on remediation of **groundwater**



- 2006 document will focus on remediation of **source-zone** media (soil, soil gas, LNAPL)

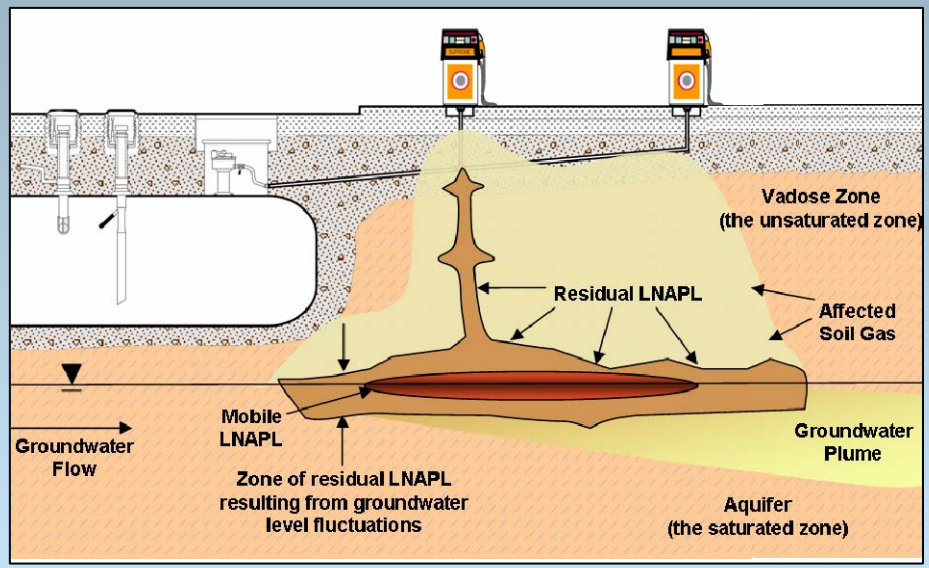


Overview of Groundwater Remediation Technologies for MTBE and TBA (ITRC, 2005)

- Includes Summaries of:
  - Physical, Chemical and Biological Processes
  - Sample Preservation and Analytical Methods
  - Site Evaluation and Cleanup Requirements
- Detailed Descriptions of Treatment Methods:
  - Groundwater Extraction and Ex-Situ Treatment
  - Air Sparging
  - In-Situ Bioremediation
  - Chemical Oxidation
  - Phytoremediation
  - Monitored Natural Attenuation
- Cost Comparison Summary

Overview of Source Zone Remediation Technologies for MTBE and TBA (ITRC, in prep.)

- **Source Zone Considerations**
  - Types of Releases and Source Zones
  - Source Zone Characterization
  - Considerations for Remedy Selection
  - Performance Monitoring
- **Remedial Technologies**
  - Excavation
  - Multi-Phase Extraction
  - Soil Vapor Extraction
  - Air Sparging
  - Enhancements to Air Sparging and Soil Vapor Extraction
  - In-Situ Chemical Oxidation
  - In Situ Bioremediation

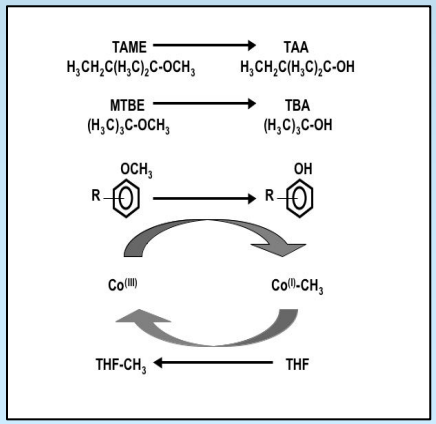


What's New in the Source Zone Remediation Document

- Classifies release mechanisms and resulting source zones
- Considers recent research on the significance of small releases at operating UST systems
- Summarizes current understanding of source-zone MTBE and TBA attenuation processes
- Provides extensive information on biodegradation processes

RELEASE CLASSIFICATION	RELEASE CHARACTERISTICS		
	Duration	Rate of Mass Release	Total Mass Released
Acute	Short Term	Low to Moderate	Small
Chronic	Long Term	Low	Small to Large
Catastrophic	Short Term	High	Large

Release Classification Matrix



Training Courses

- Previous courses:
  - New Hampshire October 2003
  - New York December 2003
  - New Jersey May 2004
  - Colorado December 2004
  - Denmark May 2005
  - Leipzig June 2005
  - California August 2005
  - Nevada March 2006

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- **Cleanup Guidance**
  - ITRC MTBE-1. 2005. Overview of Groundwater Remediation Technologies for MTBE and TBA. Interstate Technology and Regulatory Council, (ITRC) a committee of the Environmental Council of States. www.itrcweb.org.
  - ITRC MTBE-2. *in draft*. Overview of Remediation Technologies for Source Zones Containing MTBE and TBA. Interstate Technology and Regulatory Council, (ITRC) a committee of the Environmental Council of States. www.itrcweb.org.